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Merz

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(54) **ELECTRONIC DEVICE WITH INTEGRAL CONNECTORS**

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(51) **Int. Cl.**
H01R 12/00 (2006.01)

(52) **U.S. Cl.** **439/76.1**; 439/607

(58) **Field of Classification Search** 439/76.1, 439/633, 59–62, 629, 446, 607–610, 79, 439/737, 740–742, 747, 759, 756
See application file for complete search history.

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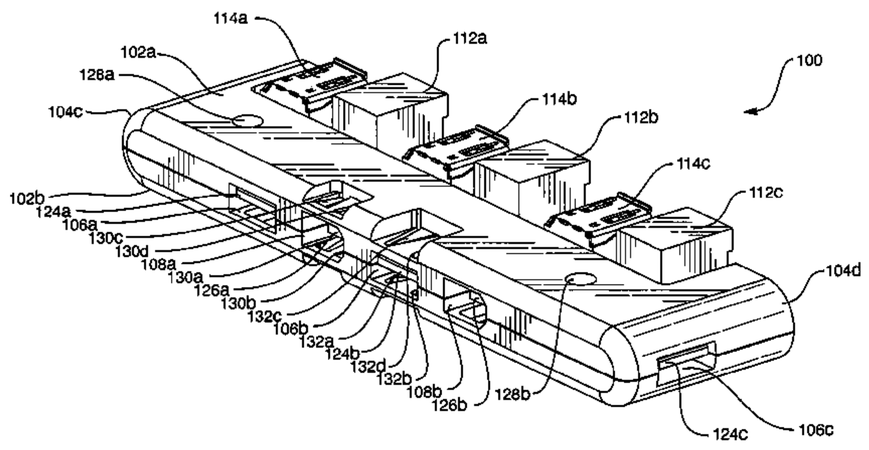
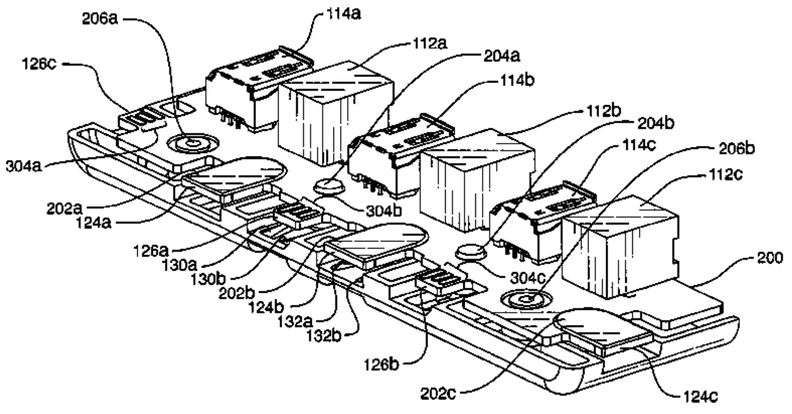
(57) **ABSTRACT**

An electronic device having one or more integral connectors is disclosed. The connector includes an electromagnetically-shielded cavity defined by an outer shell integrally formed in the housing and having a cross-sectional profile of a plug to which the connector may mate. The connector also includes a tongue integrally formed in and extending from a component (such as a printed circuit board) of the electronic device and protruding into the cavity. The tongue may have one or more electrical contacts on one or both sides. The connector may also include one or more snap features for retaining a mated plug at a predetermined force. The connectors may conform to one or more connector standards, such as the Universal Serial Bus (USB) standard and/or the IEEE 1394 (FireWire®) standard. Devices incorporating such integral connectors may be smaller and manufactured less expensively than devices having conventional, non-integral, connectors.

4 Claims, 14 Drawing Sheets





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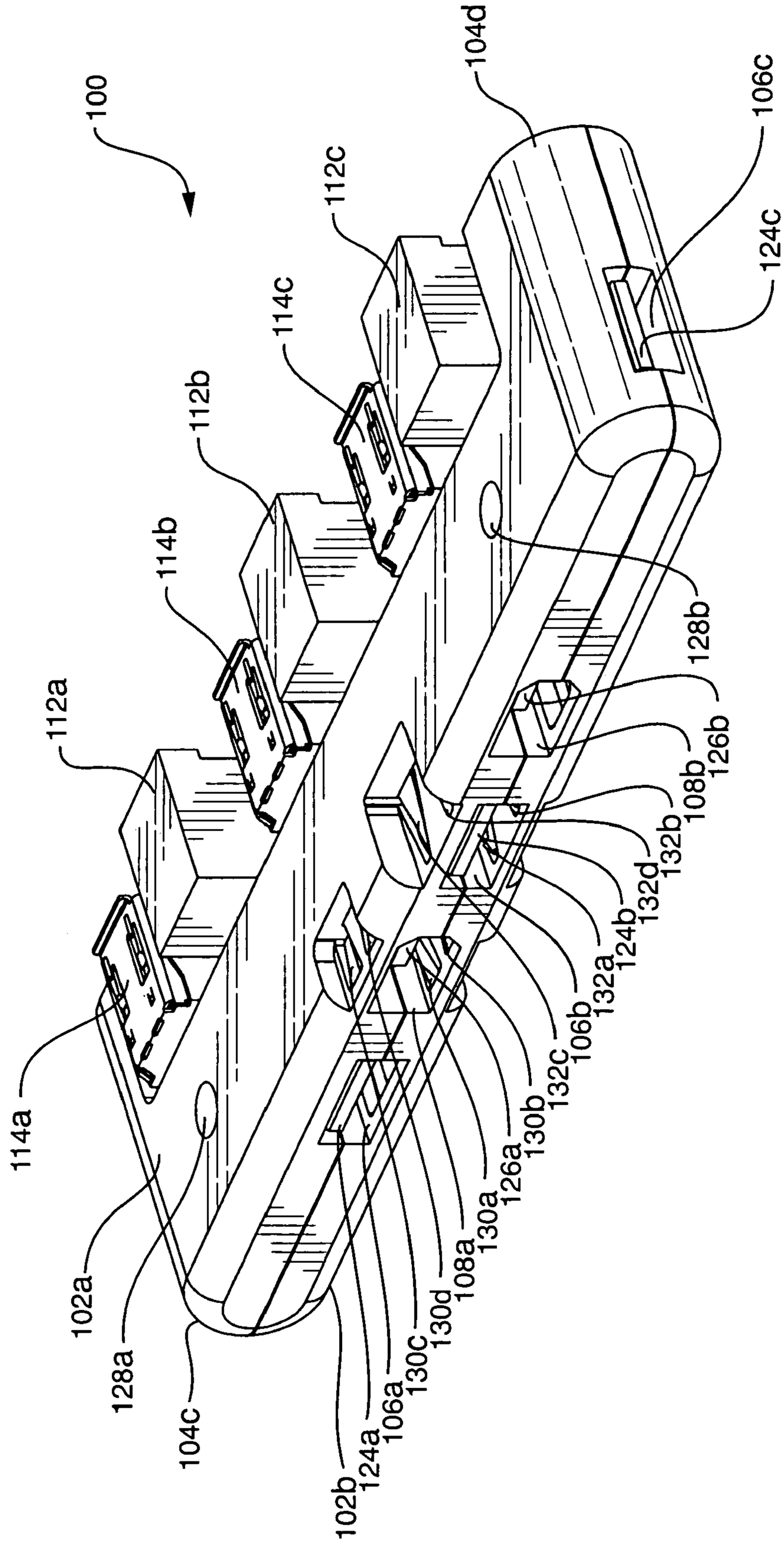
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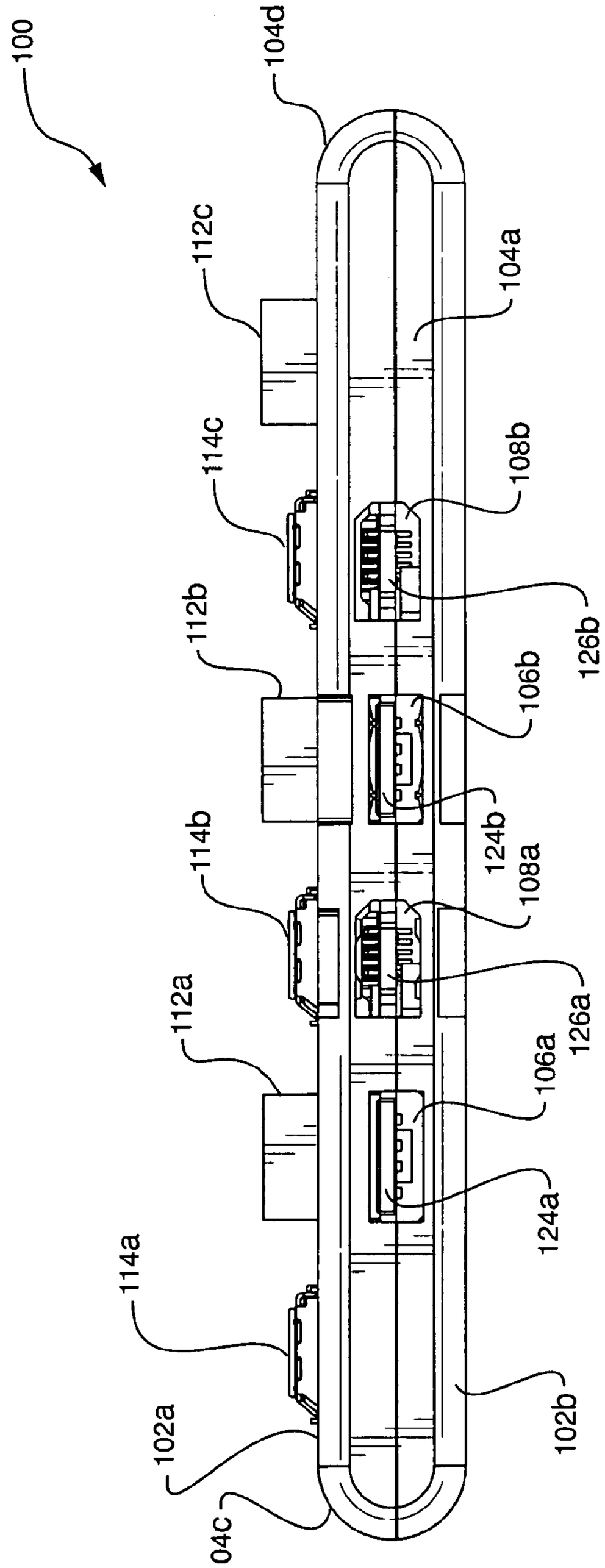
104d
106c
112c
114c
112b
114b
112a
114a
102a
128a
104c
102b
124a
106a
130c
130d
108a
130a
126a
130b
132c
106b
132a
124b
132d
132b
108b
126b
128b

FIG. 1A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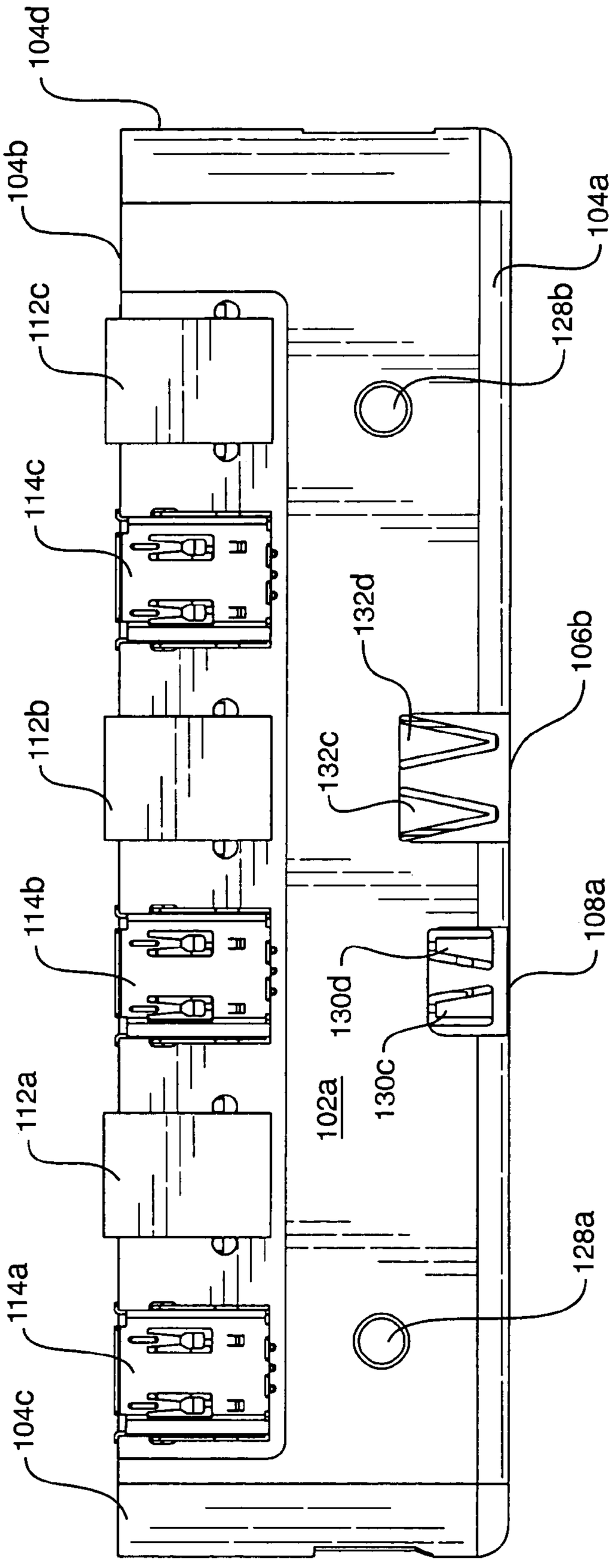
112c
104a
114c
108b
112b
106b
126b
114b
124b
108a
112a
126a
106a
114a
124a
102a
102b
104c

FIG. 1B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104b
104a
112c
128b
114c
132d
106b
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114b
130d
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112a
102a
130c
114a
128a
104c

FIG. 1C

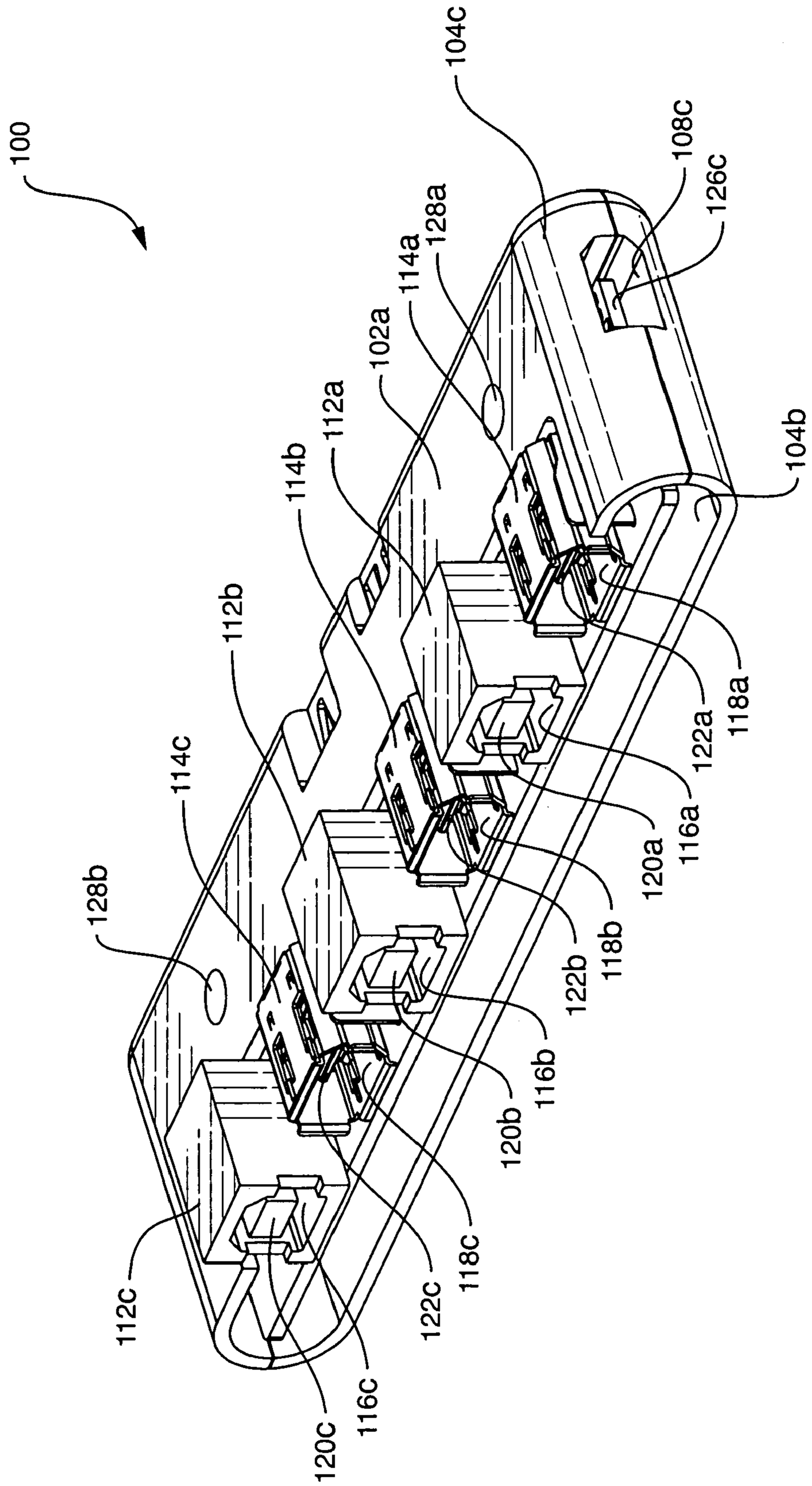

100
104c
108c
126c
128a
114a
102a
112a
114b
112b
114c
128b
104b
118a
122a
116a
120a
118b
122b
116b
120b
118c
122c
116c
120c
112c

FIG. 1D

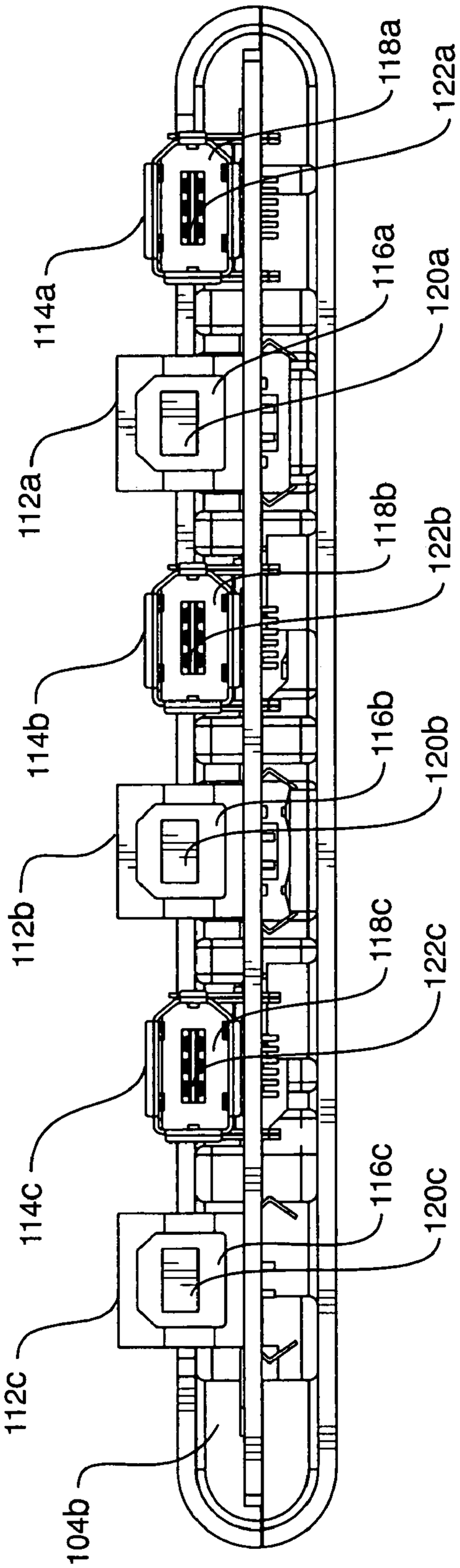

118a
122a
116a
120a
114a
112a
118b
122b
114b
116b
120b
112b
118c
122c
114c
116c
120c
112c
104b

FIG. 1E

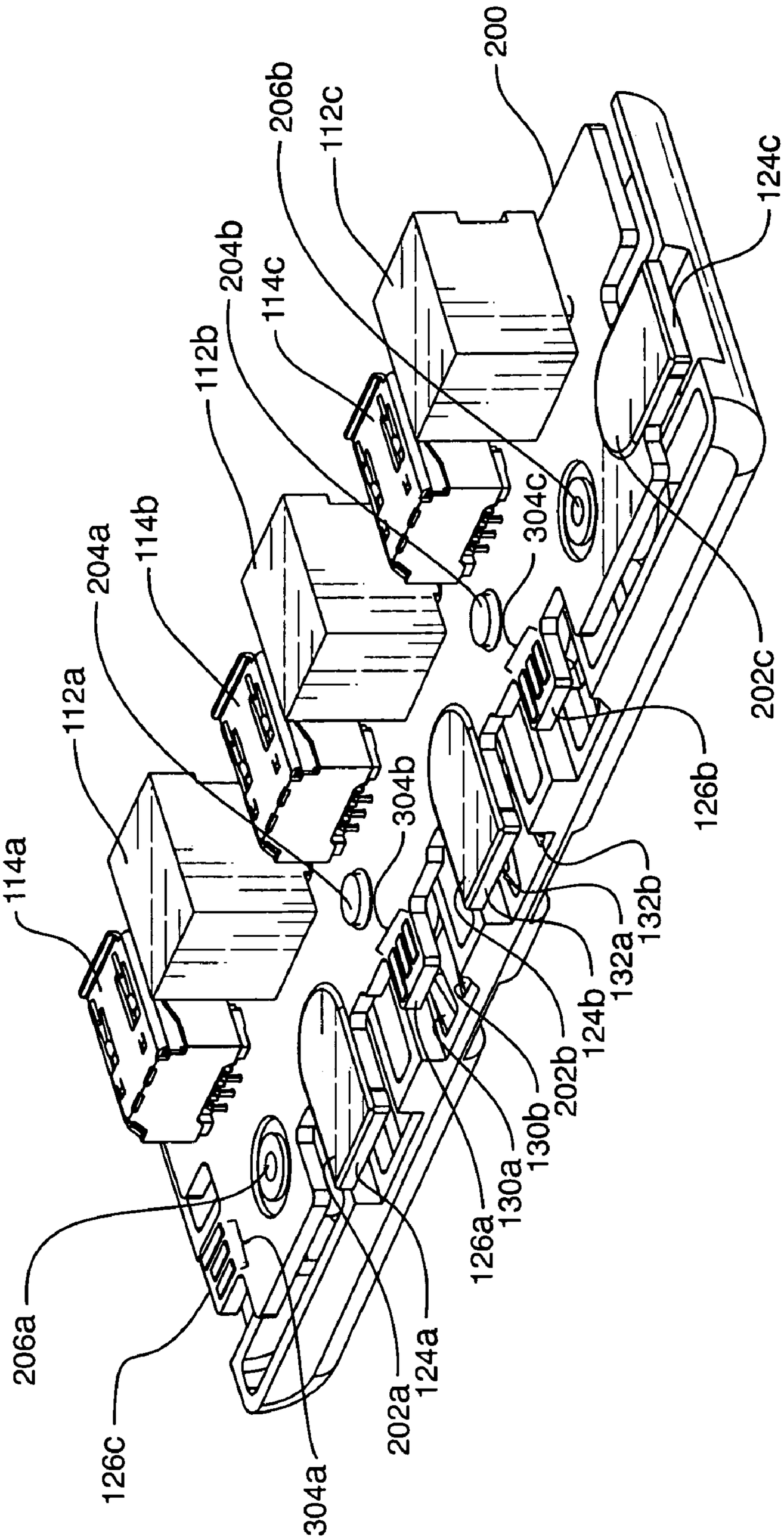

200
206b
112c
204b
114c
112b
114b
204a
112a
114a
304c
304b
126b
124c
202c
132b
132a
124b
202b
206a
126c
304a
202a
124a
126a
130a
130b

FIG. 2A

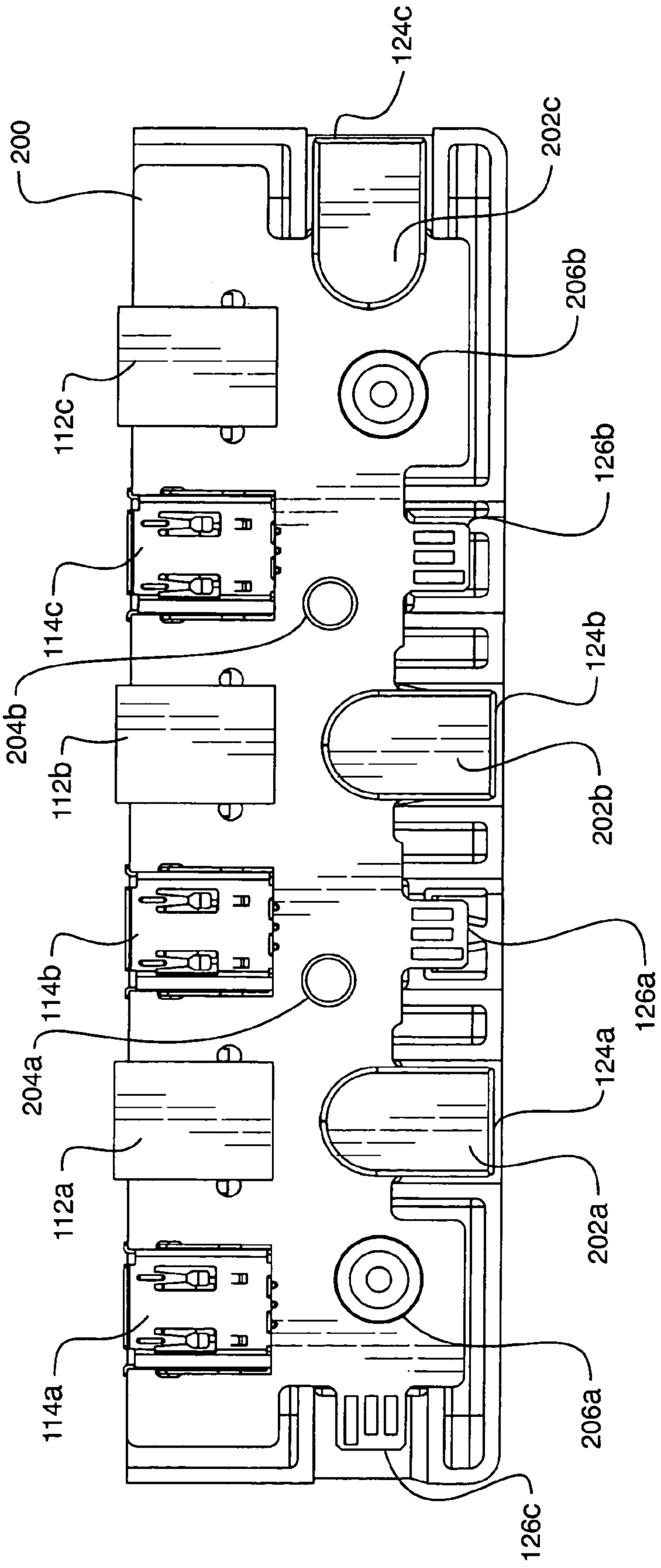

124c
200
202c
206b
112c
126b
114c
204b
124b
112b
202b
114b
126a
204a
124a
112a
202a
114a
206a
126c

FIG. 2B

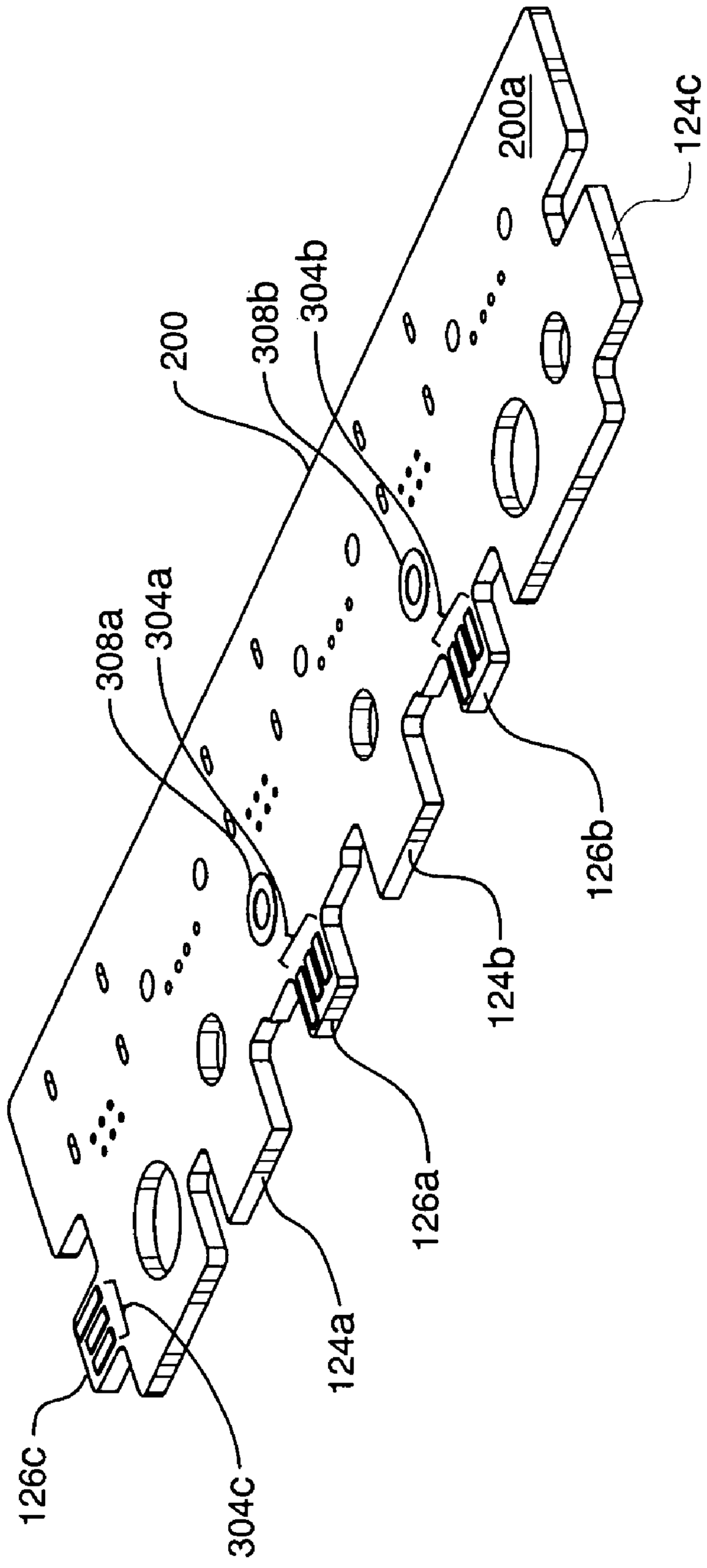

200a
124c
200
308b
304b
308a
304a
126b
124b
126a
124a
126c
304c

FIG. 3A

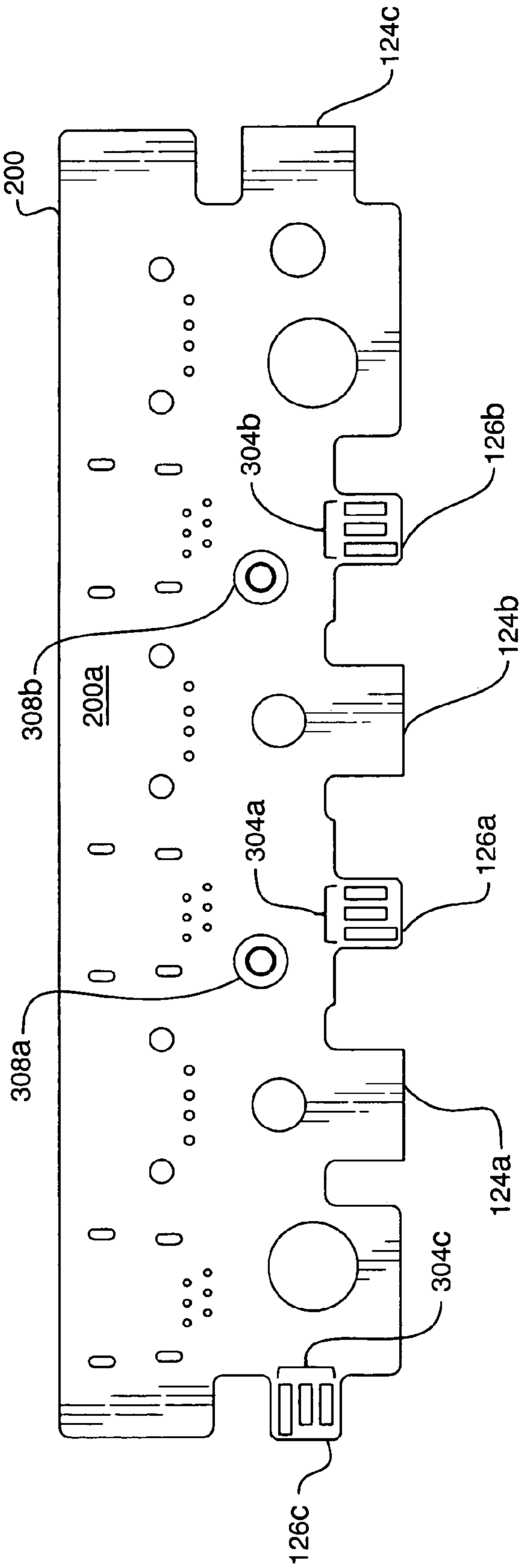

124c
200
308b
200a
304b
126b
124b
304a
126a
308a
124a
304c
126c

FIG. 3B

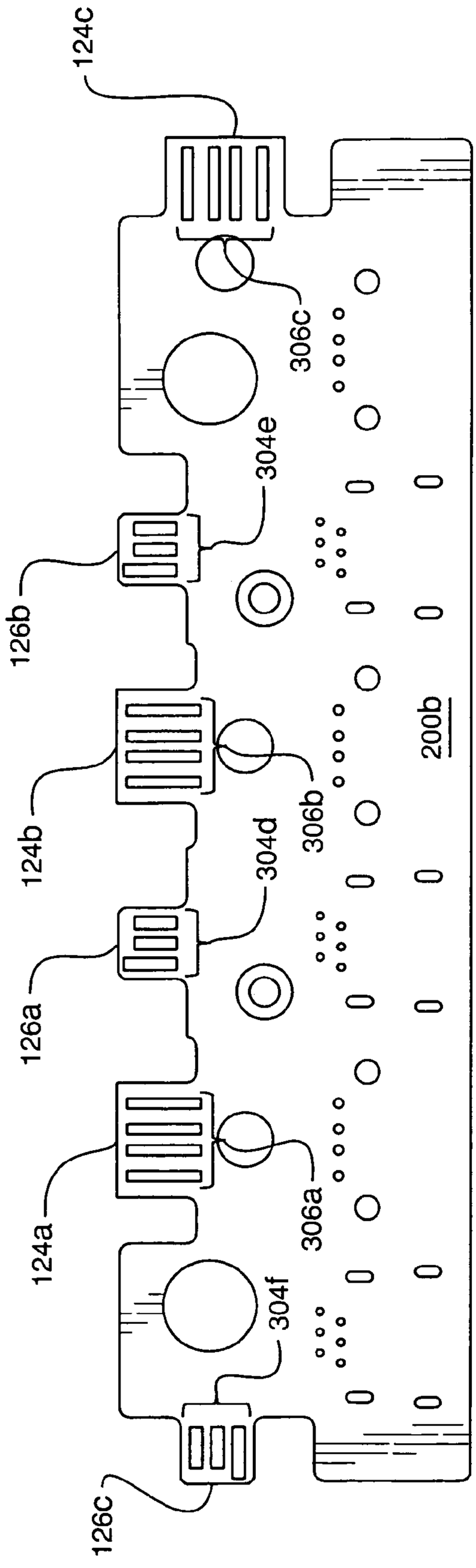
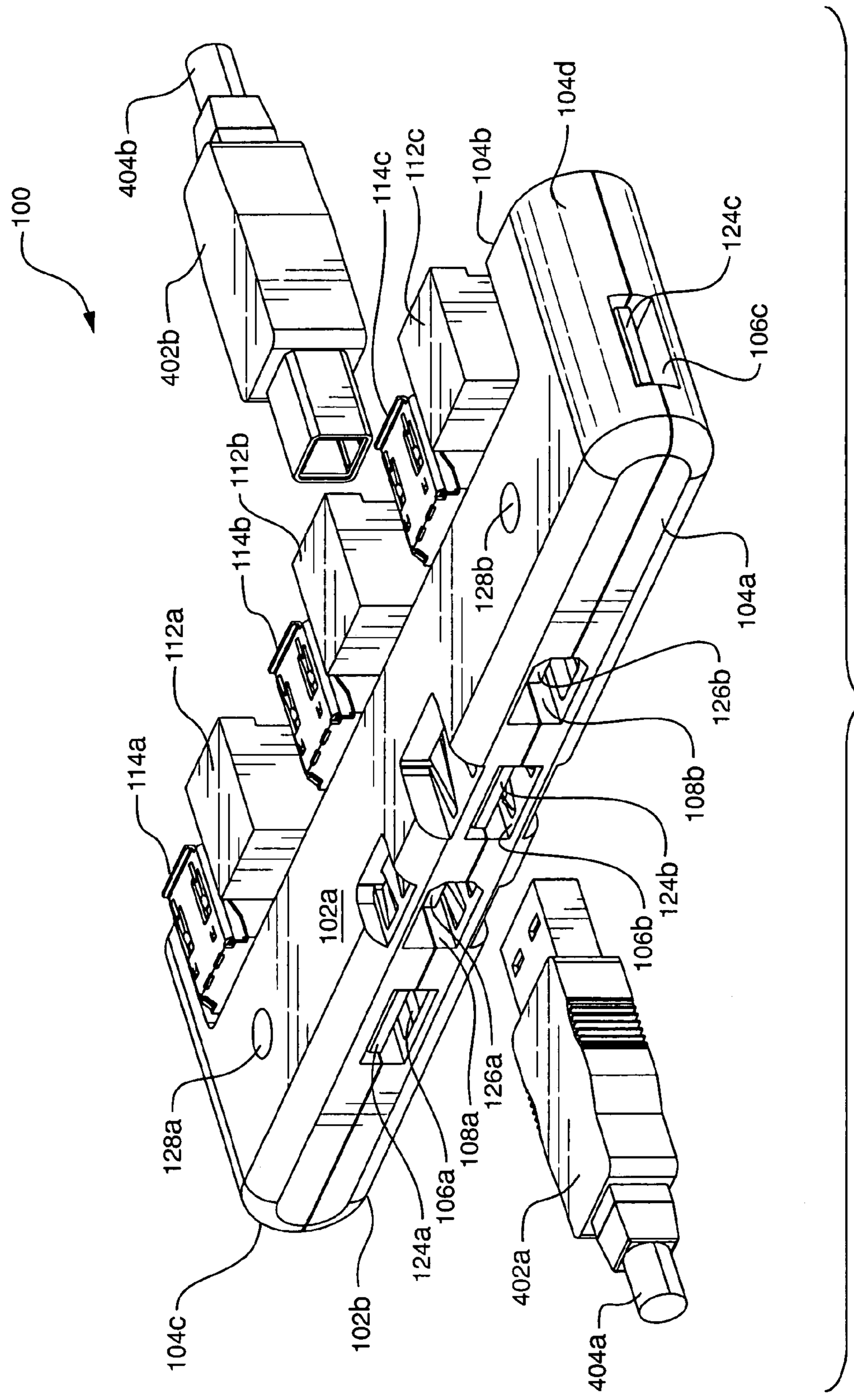

124c
306c
304e
126b
124b
304d
306b
200b
126a
124a
304f
306a
126c

FIG. 3C


100
404b
402b
114c
112c
104b
104d
124c
106c
114b
112b
128b
104a
112a
114a
126b
108b
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128a
104c
102b
124a
106a
108a
126a
402a
404a

FIG. 4A

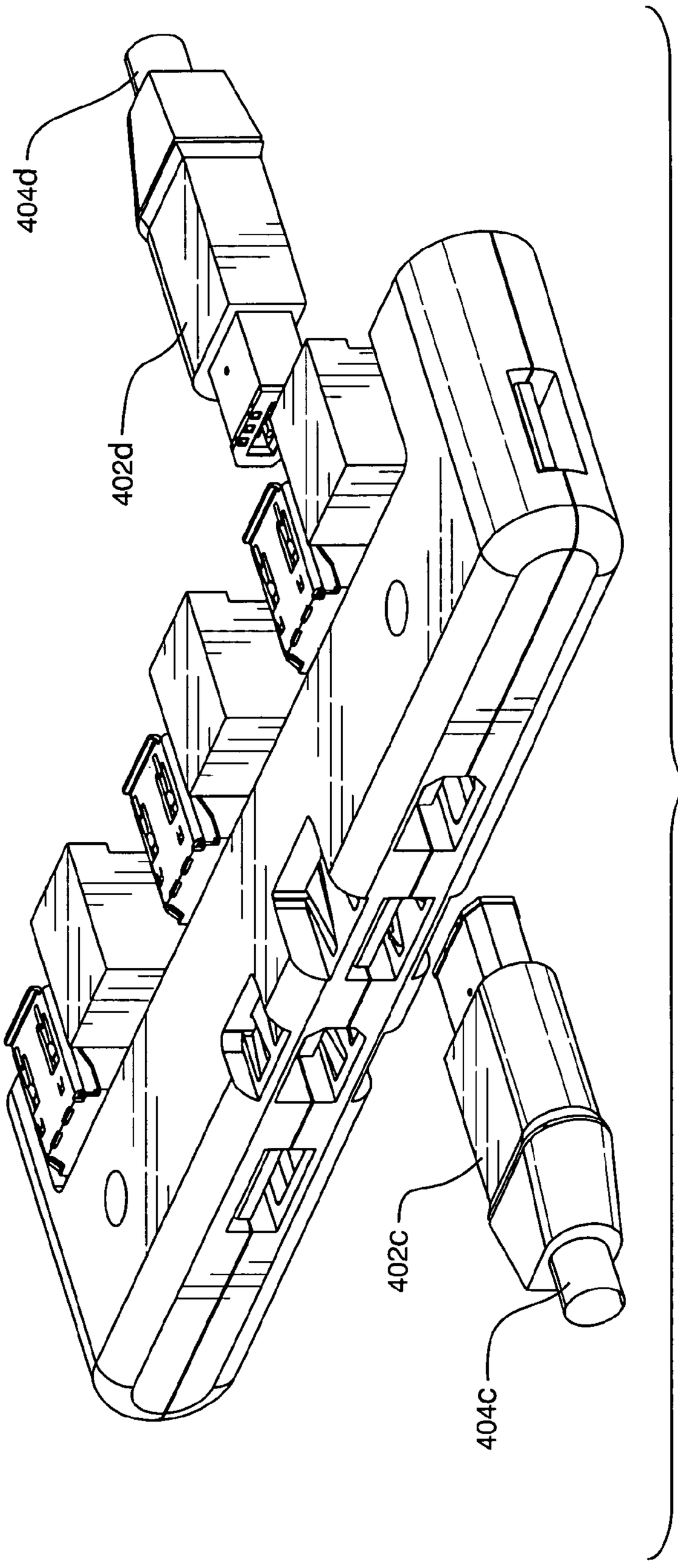

FIG. 4B

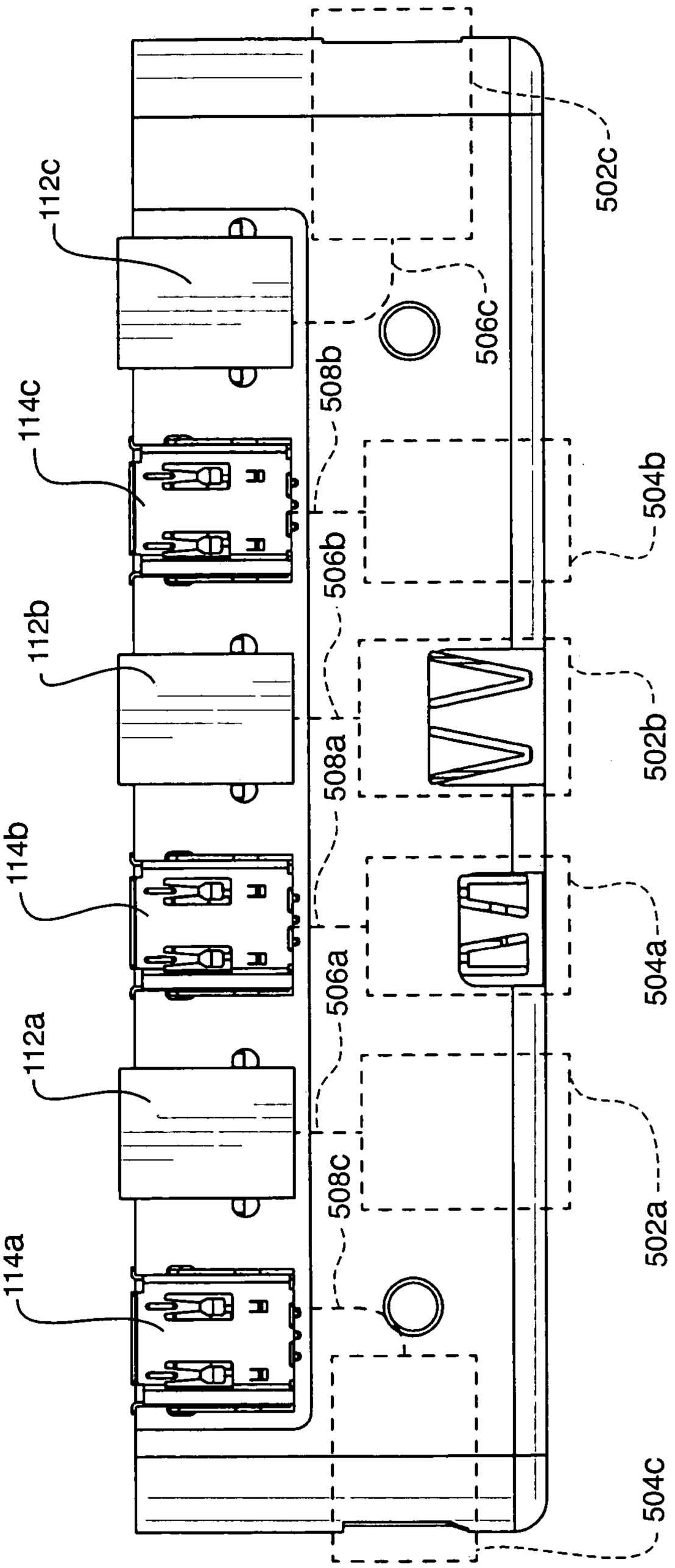
112c
114c
112b
114b
112a
114a
502c
506c
508b
504b
506b
508a
502b
504a
506a
508c
502a
504c

FIG. 5

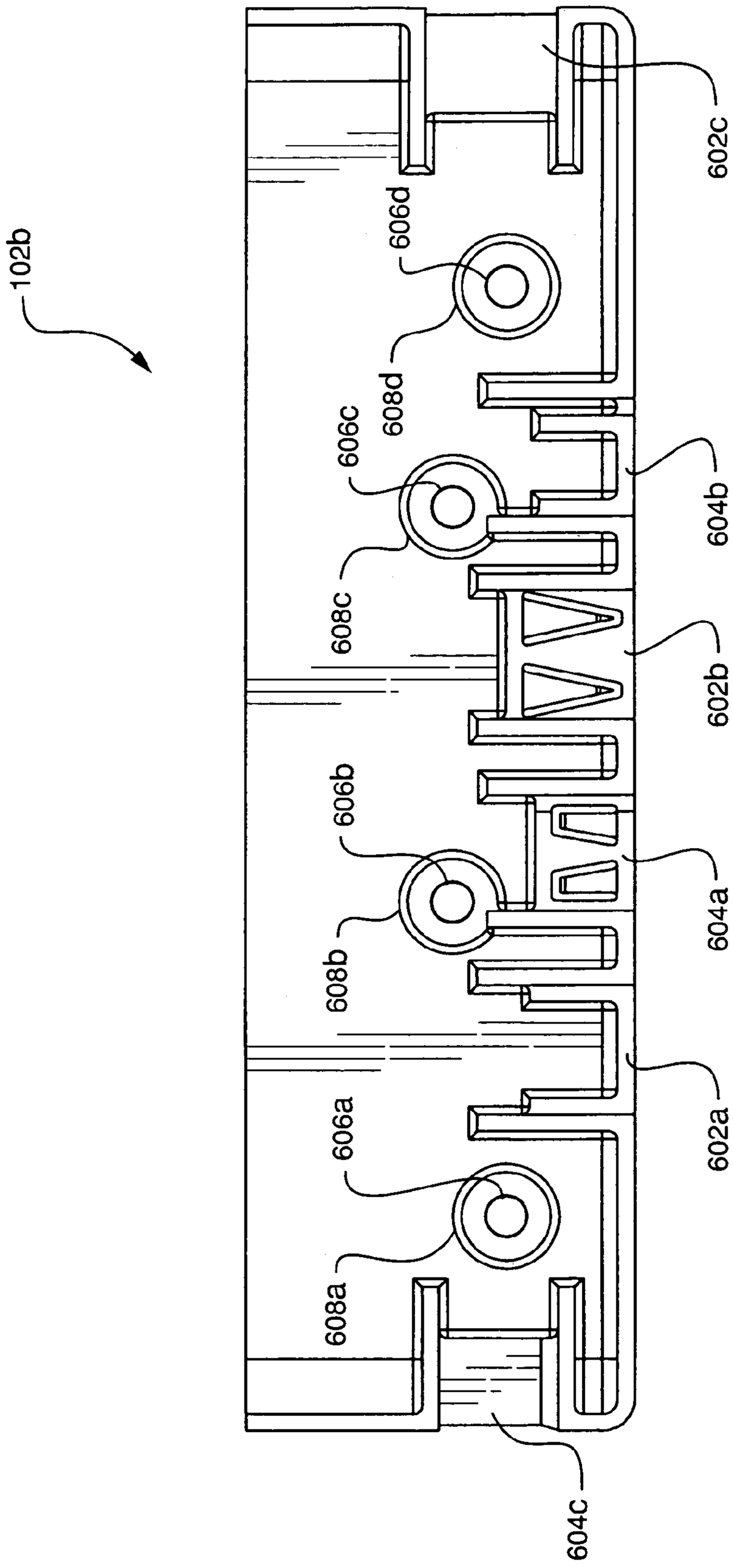
102b
602c
606d
608d
606c
608c
604b
602b
606b
608b
604a
606a
608a
602a
604c

FIG. 6

ELECTRONIC DEVICE WITH INTEGRAL CONNECTORS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional application of commonly-owned U.S. patent application Ser. No. 10/197,378, filed on Jul. 17, 2002, entitled "Electronic Device with Integral Connectors".

BACKGROUND

1. Field of the Invention

The present invention relates to electronic devices and, more particularly, to connectors for physically and electrically connecting electronic devices to each other.

2. Related Art

Electronic devices, such as personal computers, personal digital assistants (PDAs), and cellular telephones typically have electrical input and output connectors for receiving and transmitting electrical signals. Examples of such connectors include power jacks, headphone jacks, Universal Serial Bus (USB) connectors, IEEE 1394 (FireWire®) connectors, and other connectors which carry data and power into and from electronic devices.

Typically, a plug at the end of a cable is connected to a device connector, thereby forming a connection for carrying data and/or power to and from the device. Each kind of connector is designed for use with a corresponding kind of plug. Devices may typically be interconnected with each other either by connecting them together directly with cables or by connecting them indirectly through an intermediate network device, such as a hub.

Functions of connectors include: (1) making a reliable and repeatable electrical connection with the cable to which it mates, (2) making a reliable and repeatable physical connection with the cable to which it mates, and (3) providing a sufficient electromagnetic interference (EMI) seal around signals as they pass between the device and the cable. Not all connectors, however, perform all of these functions. Connectors typically are manufactured as separate metal and/or plastic components that may be soldered to a printed circuit board (PCB) or mounted to a housing and connected internally to a PCB with wires.

Although most existing connector types were originally designed for use with relatively large devices, such as desktop computers and printers, portable electronic devices increasingly use such connectors as the demand increases for portable electronic devices having communications capabilities. Mounting a conventional connector to a PCB increases the size of the PCB and may thereby increase the size of the electronic device containing the PCB. Although this may not pose a problem for relatively large electronic devices, such as desktop computers, the size increase caused by connectors may be significant in the context of portable electronic devices. The height of a connector, for example, may represent a significant fraction of the total height of a portable device. The size of conventional connectors may therefore be a limiting factor in attempts to miniaturize portable electronic devices.

What is needed, therefore, are improved techniques for providing electrical connectors within portable electronic devices.

SUMMARY

An electronic device having one or more integral connectors is disclosed. The connector includes an electromagnetically-shielded cavity defined by an outer shell integrally formed in the housing and having a cross-sectional profile of a plug to which the connector may mate. The connector also includes a tongue integrally formed in and extending from a component (such as a printed circuit board) of the electronic device and protruding into the cavity. The tongue may have one or more electrical contacts on one or both sides. The connector may also include one or more snap features for retaining a mated plug at a predetermined force. The connectors may conform to one or more connector standards, such as the Universal Serial Bus (USB) standard and/or the IEEE 1394 (FireWire®) standard. Devices incorporating such integral connectors may be smaller and manufactured less expensively than devices having conventional, non-integral, connectors.

Other features and advantages of various aspects and embodiments of the present invention will become apparent from the following description and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a perspective front view of an electronic device having integral connectors according to one embodiment of the present invention;

FIG. **1**B is a side view of the front of the electronic device of FIG. **1**A;

FIG. **1**C is a top view of the electronic device of FIG. **1**A;

FIG. **1**D is a perspective rear view of the electronic device of FIG. **1**A;

FIG. **1**E is a side view of the rear of the electronic device of FIG. **1**A;

FIG. **2**A is a perspective front view of the electronic device of FIG. **1**A with its upper housing removed;

FIG. **2**B is a top view of the electronic device of FIG. **1**A with its upper housing removed;

FIG. **3**A is a front perspective view of a printed circuit board component of the electronic device of FIG. **1**A;

FIG. **3**B is a top view of the printed circuit board of FIG. **3**A;

FIG. **3**C is a bottom view of the printed circuit board of FIG. **3**A;

FIG. **4**A is a front perspective view of the electronic device of FIG. **1**A and associated plugs for a single USB pass-through;

FIG. **4**B is a front perspective view of the electronic device of FIG. **1**A and associated plugs for a single IEEE 1394 pass-through;

FIG. **5** is a top view of the electronic device of FIG. **1**A in which embodiments of electronic connectors designed according to the present invention are illustrated in broken outline; and

FIG. **6** is a top view of the lower housing of the electronic device of FIG. **1**A with the interior surfaces of the lower housing exposed.

DETAILED DESCRIPTION

In one aspect of the present invention, an electronic device having at least one integral connector is provided. Physical and electrical features of the connectors are integrated into the housing and circuit board of the electronic device itself, thereby eliminating the need for separate connectors. The electronic device's integral connectors may

satisfy the requirements of standards such as USB and IEEE 1394 without the use of the distinct connector components that are typically used to implement connectors according to such standards. Furthermore, if multiple connector types in the electronic device share a common physical attribute, such as a central tongue with electrical contacts formed thereon, the same component in the device (e.g., the PCB) may be used to implement the common physical attribute for the multiple connector types.

In one aspect of the present invention, a connector in an electronic device may be formed from:

(1) an electromagnetically-shielded cavity formed in the housing of the electronic device, which serves as the outer shell of the connector; and

(2) a wide and flat peninsula extending from a PCB in the electronic device into the cavity and which has electrical contacts formed thereon, thereby serving as the "tongue" of the connector.

Because integral connectors designed and constructed in accordance with the present invention need not include additional components coupled to the housing of the electronic device, the use of such integral connectors may enable the size of the electronic device to be substantially unaffected by the inclusion of the connectors. As a result, the use of integral connectors in accordance with the present invention may enable the design of more compact electronic devices.

Referring to FIGS. **1**A-**1**E, the present invention will be described with reference to an example embodiment of an electronic device **100** which includes two kinds of integral connectors having a common physical attribute. In this particular example, both kinds of connectors are "tongue" connectors. The common physical attribute that they share is therefore a central tongue with electrical contacts formed thereon. The outer shell of a tongue connector is typically constructed of formed sheet metal and encloses a cavity having the cross-sectional profile of the plug to which it mates. Protruding from the back wall of the cavity is a wide and flat "tongue," typically constructed of plastic, having electrical contacts on one or more surfaces. The shell of the connector may have formed features (referred to as "snap" features) for retaining a mated plug at a specified force.

In this particular example, the electronic device **100** includes both Universal Serial Bus (USB) connectors **502***a-c* and IEEE 1394 connectors **504***a-c* (FIG. **5**), both of which are examples of "tongue" connectors. USB is defined in the Universal Serial Bus Specification, Revision v2.0, dated Apr. 27, 2000, hereby incorporated by reference. FireWire is defined by IEEE Standard 1394b, draft 1.0, dated Feb. 25, 2000, hereby incorporated by reference. In addition to defining physical and electrical properties of connectors and corresponding plugs, these standards define communications protocols to be used to transmit and receive information, as well as physical mating conditions for connectors, such as insertion force, retention force, and cycle life.

The device **100** includes an upper housing **102***a* and a lower housing **102***b* constructed of, e.g., injection-molded plastic. Two screws **128***a-b* assemble the housings **102***a-b* to each other. Forward face **104***a* of electronic device **100** includes four cavities **106***a-b* and **108***a-b*. The portions of housings **102***a-b* which enclose cavities **106***a-b* serve as the outer shells of USB connectors designed according to the present invention, while the portions of housings **102***a-b* which enclose cavities **108***a-b* serve as the outer shells of IEEE 1394 connectors designed according to the present invention.

Electronic device **100** also includes two radiused faces **104***c* (illustrated most clearly in FIG. **1**D) and **104***d*. Face **104***c* includes a cavity **108***c* (FIG. **1**D), having the same cross-sectional profile as cavities **108***a-b*, which encloses an IEEE 1394 connector designed according to the present invention. Face **104***d* includes a cavity **106***c*, having the same cross-sectional profile as cavities **106***a-b*, which encloses a USB connector designed according to the present invention.

Each of the cavities **106***a-c* and **108***a-c* is designed to receive a corresponding (USB or IEEE 1394) plug. The portions of the housings **102***a-b* that form the cavities **106***a-c* and **108***a-c* have the cross-sectional profiles of the corresponding (USB or IEEE 1394) plug to which they mate and thereby serve as the outer shells of (USB or IEEE 1394) tongue connectors. Therefore, the dimensions of cavities **106***a-c* conform to the requirements of the USB specification and the dimensions of cavities **108***a-c* conform to the requirements of the IEEE 1394 specification. The cavity-forming portions of the housings **102***a-b* may be lined with an EMI-shielding substrate. As described in more detail below, the cavity-forming portions of the housings **102***a-b* may also have snap features for retaining a mated plug at a specified force.

Referring to FIGS. **2**A-**2**C, the electronic device **100** also includes a printed circuit board (PCB) **200**, two screws **204***a-b* to mount the PCB **200** to the lower housing **102***b*, and two threaded brass inserts **206***a-b* which have been heat-staked into the lower housing **102***b*. The inserts **206***a-b*, which are threaded internally, knurled externally, and flanged, are heated and pressed into bosses **608***a* and **608***d*, respectively, in lower housing **102***b* (described in more detail below with respect to FIG. **6**). Referring to FIGS. **3**A-**3**B, the PCB **200** is illustrated in isolation. Tongues **126***a-c* are integral to the PCB **200** and protrude within cavities **108***a-c* to serve as the tongues of IEEE 1394 connectors **504***a-c* (FIG. **5**). Therefore, the dimensions of tongues **126***a-c* are the dimensions required by the IEEE 1394 specification. Tongues **126***a-c* include both contacts **304***a-c* on the top side **200***a* of PCB **200** (FIGS. **3**A-**3**B) and contacts **304***d-f* on the bottom side **200***b* of PCB **200** (FIG. **3**C).

Tongues **124***a-c* are also integral to the PCB **200** and protrude within cavities **106***a-c* to serve as the tongues of USB connectors **502***a-c* (FIG. **5**). Tongues **124***a-c* include bottom-side contacts **306***a-c* only (FIG. **3**C). PCB **200** includes two mounting-hole ground pads **308***a-b*, which are connected electrically to the grounds of each of the connectors **502***a-c* and **504***a-c*.

The thickness of the IEEE 1394 tongues **126***a-c* (on the PCB **200** is the thickness required by the IEEE 1394 specification, since the IEEE 1394 specification requires contacts on both sides of the PCB **200**. The USB specification specifies a thicker tongue but only requires contacts on one side of the PCB **200**, so plastic spacers **202***a-c* are attached to the top sides of tongues **124***a-c* on top side **200***a* of PCB **200** to account for the difference between the thickness of the PCB **200** and the tongue thickness required by the USB specification. The dimensions of the USB connectors **502***a-c* and the IEEE 1394 connectors **504***a-c* are described in detail in the respective USB and IEEE 1394 specifications referenced above.

Plastic snaps may be included in the housings **102***a-b* as physical retention features for the plugs (e.g., plugs **402***a-d* illustrated in FIGS. **4**A-**4**B). For example, the housings **102***a-b* include plastic snaps **130***a-d* and **132***a-d* for connectors **504***a* and **502***b*, respectively. Snaps **130***a-d* and

132*a-d* each include elements in both the upper housing **102***a* and lower housing **102***b* for retaining a mated plug (e.g., plug **402***a*) at a specified force. Physical characteristics of snaps **130***a-d* and **132***a-d* are consistent with the requirements of the IEEE 1394 and USB specifications, respectively; those of ordinary skill in the art will therefore appreciate how to design and construct snaps **130***a-d* and **132***a-d*.

Rearward face **104***b* (illustrated most clearly in FIGS. **1**D and **1**E) includes three conventional USB connectors **112***a-c* and three conventional IEEE 1394 connectors **114***a-c* which are connected electrically to corresponding ones of the connectors **502***a-c* and **504***a-c*, respectively (as described in more detail below with respect to FIG. **5**).

Conventional USB connectors **112***a-c* (shown most clearly in FIGS. **1**C-**1**E) include outer shells enclosing cavities **116***a-c* and having tongues **120***a-c*, respectively. USB connectors **112***a-c* are conventional external connectors which, as may be seen in FIGS. **1**A-**1**E, increase the overall height of device **100** substantially. Similarly, conventional IEEE 1394 connectors **114***a-c* include outer shells enclosing cavities **118***a-c* and having tongues **122***a-c*, respectively. IEEE 1394 connectors **114***a-c* are conventional external connectors which, although somewhat smaller than USB connectors **112***a-c*, increase the overall height of device **100** noticeably.

For example, referring to FIG. **1**C, the depicted embodiment of the electronic device **100** is approximately 137.55 mm wide by 36.85 mm deep. Referring to FIG. **1**B, the height of the device **100** measured from the bottom of the lower housing **102***b* to the top of the upper housing **102***a* (which includes all of the connectors **502***a-c* and **504***a-c*) is approximately 14 mm tall. If the additional height contributed by the conventional connectors **112***a-c* and **114***a-c* is included, the height of the device **100** (measured from the bottom of lower housing **102***b* to the top of connectors **112***a-c*) is approximately 19.17 mm, a difference of over 35%.

Each of the three USB tongues **124***a-c* and the three IEEE 1394 tongues **126***a-c* is connected electrically to a corresponding conventional USB or IEEE 1394 connector on the PCB **200**, thereby essentially creating six short extension cords. Referring to FIG. **5**, for example, a top view of the electronic device **100** is shown which points out electrical connectors **502***a-c* and **504***a-c* which are designed according to the present invention. FIG. **5** also illustrates the paths **506***a-c* and **508***a-c* of electrical connections between the conventional connectors (**112***a-c* and **114***a-c*) and the connectors (**502***a-c* and **504***a-c*) designed according to the present invention.

In one embodiment, the elements of integral USB connector **502***a* are:

(1) molded cavity **106***a*, formed by housings **102***a-b* of the electronic device **100** and shaped according to the USB specification;

(2) tongue-shaped peninsula **124***a* from the PCB **200**, protruding into the cavity **106***a;*

(3) four conductive pads **306***a* on the bottoms only of the tongue **124***a;*

(4) plastic spacer **202***a*, the size and shape of the tongue **124***a*, on the top of the tongue **124***a*, to make the tongue **124***a* physically thicker, according to the USB specification;

(5) conductive plating on inner surface **602***a* of cavity **106***a* for EMI shielding; and

(6) molded plastic snaps **132***a-d* in the housings **102***a-b*, protruding into the cavity **106***a*.

The other USB connectors **502***b-c* have corresponding elements. It should be appreciated however, that connectors designed according to the present invention need not include all of the elements listed above.

The elements of the integral IEEE 1394 connector **504***a* are:

(1) molded cavity **108***a*, formed by housings **102***a-b* of the electronic device **100**, shaped according to the IEEE 1394 specification;

(2) tongue-shaped peninsula **126***a* from the PCB **200**, protruding into the cavity **108***a;*

(3) three conductive pads **304***a* on the top and three conductive pads **304***d* on the bottom of tongue **126***a;*

(4) conductive plating on inner surface **604***a* of cavity **108***a* for EMI shielding; and

(5) molded plastic snaps **130***a-d* in the housings X**102***a-b*, protruding into the cavity **108***a*.

The other IEEE 1394 connectors **504***b-c* have corresponding elements. It should be appreciated, however, that connectors designed according to the present invention need not include all of the elements listed above.

USB connectors **502***a-c* are connected to conventional USB connectors **112***a-c* along electrical paths **506***a-c*, respectively. Similarly, IEEE 1394 connectors **504***a-c* are connected to conventional IEEE 1394 connectors **114***a-c* along electrical paths **508***a-c*, respectively. Although electrical paths **506***a-c* and **508***a-c* are illustrated in single lines in FIG. **5** for ease of illustration, such paths may in practice be implemented using electrical connections in accordance with the USB or IEEE 1394 specification using well-known techniques. The device **100** thereby performs the function of six short extension cords for extending the reach of USB and IEEE 1394 connections by a short distance. It should be appreciated that the design features embodied in the connectors **502***a-c* and **504***a-c* may, however, be used to implement similar connectors in any of a variety of devices for performing any of a variety of functions.

EMI shielding may be provided within the electronic device **100** in any of a variety of ways. For example, nickel-plating or copper paint may be used to provide EMI shielding for plastic, as is well-known to those of ordinary skill in the art. Conductive plastics, such as plastic filled with nickel-plated carbon fiber strands, are inherently EMI-absorptive and do not require additional EMI shielding. Furthermore, if the housings **102***a-b* are constructed of metal (such as cast magnesium), separate EMI shielding may not be required.

Referring to FIG. **6**, for example, a top view of the lower housing **102***b* is shown with the interior surfaces of the lower housing **102***b* exposed. Examples of surfaces on the interior of lower housing **102***b* are shown which may be nickel-plated. In particular, inner surfaces **602***a-c* and **604***a-c* of cavities **106***ac* and **108***a-c*, respectively, and top surfaces **606***a-d* of mounting bosses **608***a-d* may be nickel-plated. Inner surfaces of the cavities **106***a-c* and **108***a-c* create a Faraday cage around the connectors **502***a-c* and **504***a-c*, respectively, when mated and thus provide EMI shielding. In practice, all inner surfaces of the lower housing **102***b* may be plated, rather than merely plating surfaces **602***a-c*, **604***a-c*, and **606***a-d*.

The two mounting bosses **608***b-c* where the PCB **200** is screwed to the lower housing **102***b* are encircled by wide ground pads **308***a-b* (FIGS. **3**A-**3**C), electrically tying the conductive plating on the inner surfaces (**602***a-c*, **604***a-c*, and **606***a-d*) of the lower housing **102***b* (FIG. **6**) to the electrical grounds of the USB connectors **502***a-c* and IEEE

1394 connectors **504***a-c* themselves. Thus, the plating inside the lower housing **102***b* acts as an effective EMI shield for plugs **402***a-d*.

Referring to FIGS. **3**A-**3**B, printed circuit board (PCB) **200** of electronic device **100** is illustrated, the upper housing **102***a* being removed from view to expose the PCB **200**. Two conductive mounting screws **204***a-b* physically couple the PCB **200** to the lower housing **102***b* at the mounting bosses **608***b-c* and complete the ground path from the connectors **502***a-c* and **504***a-c* to the plating on the lower housing **102***b*.

FIG. **4**A illustrates the insertion of plugs **402***a-b* at the ends of cables **404***a-b*, respectively, completing the electrical path to test one of the USB connections (formed by connecting USB connectors **502***b* and **112***b*). FIG. **4**B illustrates the insertion of plugs **402***c-d* at the ends of cables **404***c-d*, respectively, completing the electrical path to test one of the IEEE 1394 connections (formed by connecting IEEE 1394 connectors **504***b* and **114***c*). FIGS. **4**A and **4**B demonstrate that the device **100** performs the function of six short extension cables and is useful as a test bed for features of various embodiments of the present invention as it relates specifically to USB and IEEE 1394.

Among the advantages of the invention are one or more of the following.

One advantage of various embodiments of the present invention is that the overall thickness of the electronic device **100** may be reduced dramatically compared to the thickness of a device solely incorporating conventional connectors (such as connectors **112***a-c* and **114***a-c*). Furthermore, adjacent connectors (such as connectors **502***a* and **504***a*) designed according to the present invention may be spaced and positioned more tightly together in comparison to conventional connectors. As electronic devices continue to be miniaturized, these design advantages will increase in significance.

A further and related advantage of various embodiments of the present invention is that existing components in an electronic device are utilized to provide the elements of connectors. For example, the architecture of the electronic device **100** effectively replaces the separate connectors of conventional electronic devices with the combination of housing cavities **106***a-c* and **108***a-c* and exposed tongues **124***a-c* and **126***a-c* of PCB **200**. Because virtually all modern electronic devices have an outer housing and a printed circuit board, connectors designed according to the present invention may be implemented in such devices without the use of additional components.

Similarly, in embodiments of the present invention, the physical retention typically provided by snap features in a conventional connector may be molded directly into the housing itself or may be implemented in a separate component attached to the housing. The EMI shielding function typically performed by the formed metal shell of a conventional connector may be performed by conductive plating on the inside of the housing. This conductive plating may be tied electrically to exposed ground pads on the PCB, or may be inherent if the housing material is itself conductive.

In embodiments of the present invention, the electrical repeatability function for a given number of mating cycles that is typically provided by a conventional connector is determined by the resilience of the contacts on the PCB. This resilience may easily be chosen during the manufacturing stage.

The use of fewer and smaller components may enable devices that incorporate connectors designed according to the present invention to be manufactured less expensively than devices incorporating conventional connectors.

The description herein refers to "connections" which may be formed using "connectors." As used herein, the term "connection" refers to any kind of connection between two elements, such as an electrical connection characterized by electrical continuity between two elements (such as plug **402***a* and connector **502***b*) or a physical retention between the two elements. As used herein, the term "connector" refers to a device that provides an electrical connection between two elements, a mechanical connection between two elements, or both. A connector may also provide EMI shielding of an electrical connection.

Although the particular electronic device **100** illustrated and described herein includes USB and IEEE 1394 connectors, embodiments of the present invention are not limited to use with these kinds of connectors. Connectors designed in accordance with the present invention may, for example, include other kinds of tongue connectors. For example, connectors that are used for docking laptops and handheld devices into docking stations are typically tongue connectors and may be designed in accordance with the techniques described herein. Furthermore, devices designed in accordance with the present invention may, for example, use a single component to implement a common physical attribute (including, but not limited to, a tongue) of multiple types of connectors in the device. Although the particular electronic device **100** illustrated and described herein includes three USB connectors **502***a-b* and three IEEE 1394 connectors **504***a-c*, devices designed in accordance with the present invention may include any number and type of connector in any combination.

Although the connectors **502***a-c* and **504***a-c* are described herein as "integral" connectors, not every feature of connectors designed in accordance with the present invention need be integrated with other components of the electronic device of which they are a part. For example, the snap features may be distinct components that are not integral to the housings **102***a-b* of the device **100**.

It is to be understood that although the invention has been described above in terms of particular embodiments, the foregoing embodiments are provided as illustrative only, and do not limit or define the scope of the invention, which is defined by the following claims.

What is claimed is:

1. An electronic device comprising:

a housing;

a first connector comprising:

a first cavity defined by at least one first interior portion of the housing, the at least one first interior portion comprising a first outer shell, the first outer shell comprising a first surface integrally formed in one piece with the housing, the first surface facing an interior of the first cavity, the first outer shell cavity having a first cross-sectional profile of a first plug to which the first connector may mate;

a first tongue integrally formed in one piece with and extending from a printed circuit board of the electronic device and protruding into the first cavity;

a spacer coupled to a surface of the first tongue, wherein the combined thickness of the first tongue and the spacer comply with thickness requirements of the first connector standard; and

wherein properties of the first connector comply with requirements of a first connector standard; and

a second connector comprising:

a second cavity defined by at least one second interior portion of the housing, the at least one second interior portion comprising a second outer shell, the

second outer shell comprising a second surface integrally formed in one piece with the housing, the second surface facing an interior of the second cavity, the second outer shall cavity having a second cross-sectional profile of a second plug to which the second connector may mate;

a second tongue integrally formed in one piece with and extending from the printed circuit board of the electronic device and protruding into the second cavity; and

wherein properties of the second connector comply with requirements of a second connector standard;

wherein the housing includes the first connector and the second connector.

2. An electronic device comprising:

a housing;

a first connector comprising:

a first cavity defined by a first outer shell integrally formed in the housing and having a first cross-sectional profile of a first plug to which the first connector may mate;

a first tongue integrally formed in and extending from a component of the electronic device and protruding into the first cavity; and

a spacer coupled to a surface of the first tongue;

a second connector comprising:

a second cavity defined by a second outer shell integrally formed in the housing and having a second cross-sectional profile of a second plug to which the second connector may mate; and

a second tongue integrally formed in and extending from the component of the electronic device and protruding into the second cavity;

wherein properties of the first connector comply with requirements of a first connector standard and wherein properties of the second connector comply with requirements of a second connector standard that differs from the first connector standard; and

wherein the combined thickness of the first tongue and the spacer comply with thickness requirements of the first connector standard.

3. An electronic device comprising:

a housing;

a first connector comprising:

a first cavity defined by a first outer shell integrally formed in the housing and having a first cross-sectional profile of a first plug to which the first connector may mate;

a first tongue integrally formed in and extending from a printed circuit board of the electronic device and protruding into the first cavity; and

a spacer coupled to a surface of the first tongue;

wherein properties of the first connector comply with requirements of a first connector standard, and wherein the combined thickness of the first tongue and the spacer comply with thickness requirements of the first connector standard; and

a second connector comprising:

a second cavity defined by a second outer shell integrally formed in the housing and having a second cross-sectional profile of a second plug to which the second connector may mate;

a second tongue integrally formed in and extending from the printed circuit board of the electronic device and protruding into the second cavity; and

wherein properties of the second connector comply with requirements of a second connector standard.

4. An electronic device comprising:

a housing;

a first connector comprising:

a first cavity defined by a first outer shell integrally formed in the housing and having a first cross-sectional profile of a first plug to which the first connector may mate;

a first tongue integrally formed in and extending from a first component of the electronic device and protruding into the first cavity; and

a spacer coupled to a surface of the first tongue;

a second connector comprising:

a second cavity defined by a second outer shell integrally formed in the housing and having a second cross-sectional profile of a second plug to which the second connector may mate; and

a second tongue integrally formed in and extending from a second component of the electronic device and protruding into the second cavity;

wherein properties of the first connector comply with requirements of a first connector standard and wherein properties of the second connector comply with requirements of a second connector standard that differs from the first connector standard; and

wherein the combined thickness of the first tongue and the spacer comply with thickness requirements of the first connector standard.

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